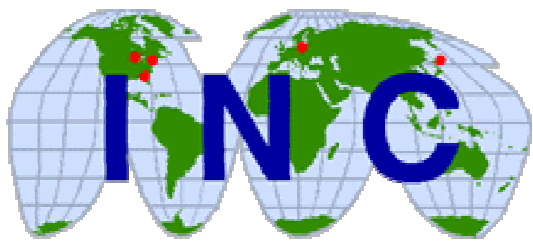


# A Symbolic Environment for Visualization of Activated Foci in Functional Neuroimaging Datasets



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## Abstract

*Corner Cube* is a software package that can be used to extract activated foci from neuroimaging datasets and visualize them as symbolic representations in a three-dimensional anatomical context. Foci are extracted by thresholding a data volume and identifying the distinct clusters that remain; statistical metrics are calculated and Talairach locations and anatomical labeling are reported for each focus. Alternatively, foci that have been reported in the literature using Talairach millimetric coordinates can be imported to Corner Cube via a few lines of formatted text. The foci are represented by symbols that preserve the centroid and volume of the clustered voxels; symbols can vary in complexity from spheres to surface renderings of the clusters. Anatomical context is provided by presenting MRI images on three walls (a corner) of the cube bounding the dataset and projecting the outlines of the foci onto the walls.

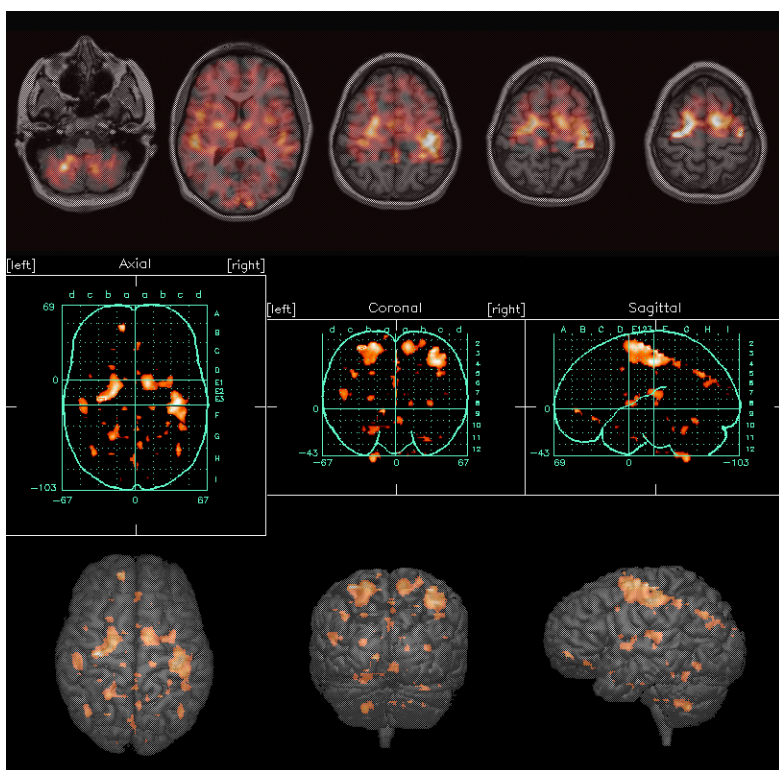
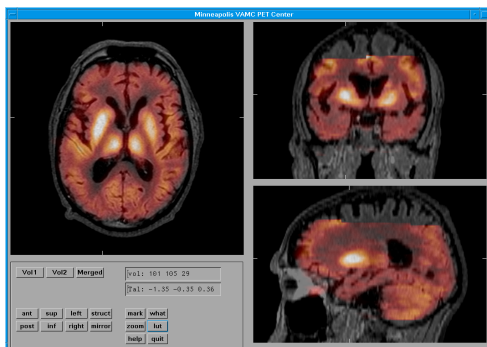
The advantages of the approach are: an entire dataset can be summarized in a single picture for a quick overview of the relative size and position of activated foci, two datasets can be represented simultaneously, and datasets described in the literature can be easily imported for comparison.

## Introduction

*We visualize neuroimaging data to:*

- ! understand functional activation within a single dataset
- ! compare patterns of activation across datasets

## Common Display Methods



## Strengths:

- ! good functional and anatomical detail
- ! easy to implement

## Weaknesses:

- ! hard to build up a 3D mental model of activation patterns
- ! hard to compare datasets

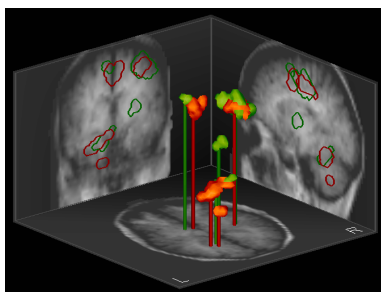
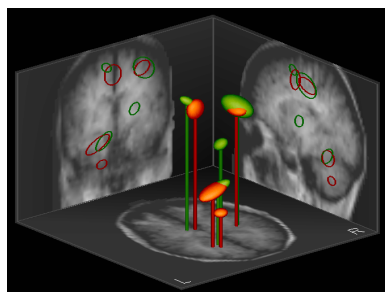
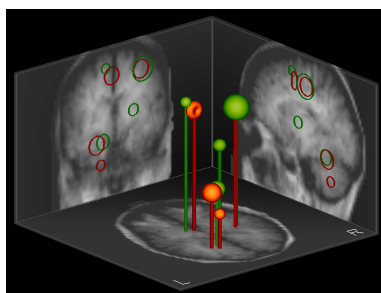
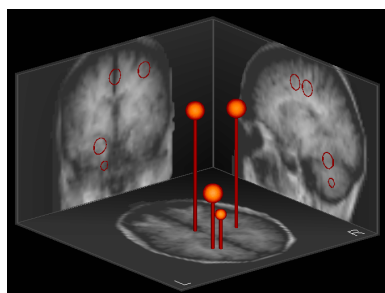
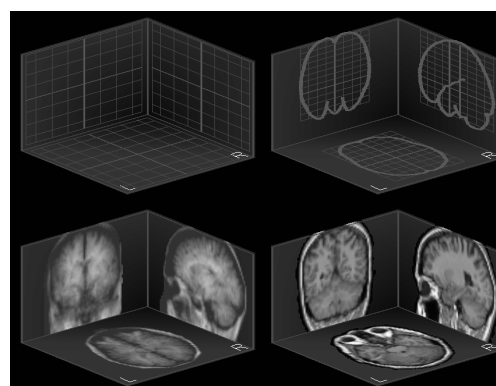
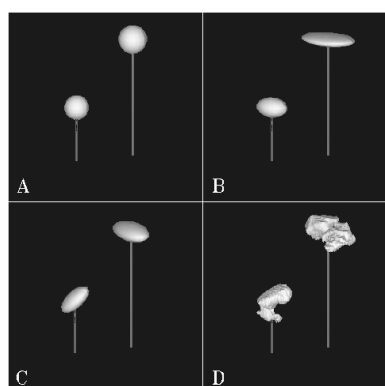
## Symbolic Representation

### Aim:

- ! to present entire functional dataset(s) at once
- ! to provide anatomical context in an unobtrusive way
- ! to eliminate need to build mental 3D models

### Symbolic Representation Approach

- ! explicitly defines foci of activation using thresholds and connected-component analysis
- ! creates simple symbols that represent basic geometrical and topological characteristics of irregular connected-components or "blobs"
- ! defines a "Corner Cube" environment for presenting anatomical reference information unobtrusively
- ! creates "anchors" that tie functional symbols to anatomy

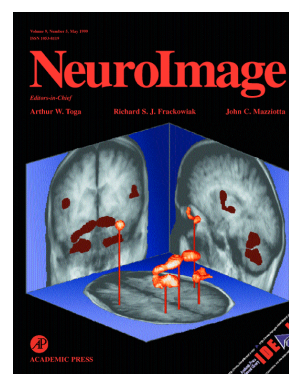
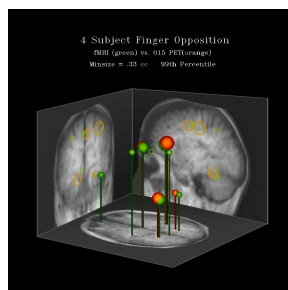


### Results of using symbols:

- ! easily distinguish foci and their relative spatial relationships
- ! spatially compact symbols allow rapid judgement of relative focus volumes
- ! effect of threshold is easily shown
- ! unusual shape or topology of blobs is revealed

## Applications:

- ! examine functional response to an activation protocol
- ! compare data analytic strategies
- ! compare subjects and groups
- ! compare protocols
- ! compare imaging modalities



## Corner Cube Software Package

### Operation:

- ! load one or two functional datasets
- ! load a coregistered anatomical reference volume
- ! select a data threshold and minimum size criterion

### Corner Cube:

- ! computes the connected suprathreshold voxels and summarizes them as a set of foci
- ! generates a symbol for each focus
- ! calculates the Talairach coordinates for the centroid and peak of each focus and looks up nearby structures in the as named in the 1988 Talairach and Tournoux atlas
- ! generates a picture using a generalized anatomical reference image

### Interactivity:

- Use menus to change symbol, stalk, outline, or wallpaper style.
- Use menu to change focus extraction threshold and recompute foci.
- Click on any focus to:
  - ! report its summary statistics
  - ! replace the generalized wallpaper with slices through its centroid or peak
  - ! pop up a window with merged functional and anatomical slices
- Save the current picture in GIF and Postscript format

### Data formats:

The program operates on 3D volume datasets, byte, integer or float, or a focus descriptor format.

Volume formats accepted are: ANALYZE, VAPET, or FOREIGN (the user must define a layout file). If supplying the Talairach millimetric coordinates of the corners of the volume describe all locations completely then Corner Cube will report structure names.

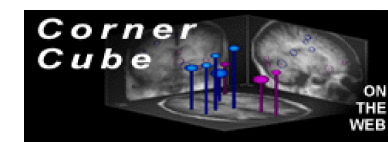
Focus descriptor format is a simple ASCII file in which each focus in a dataset is described by its centroid, volume, peak and average signal value. Focus descriptors can be interpreted as coregistered with the default reference volume supplied with the package.

### System Requirements

- ! requires IDL development licence version 5.0 or higher
  - ! requires 8-bit pseudo-color display.
  - ! appears best on displays larger than 1024x768
  - ! requires a c compiler
  - ! recommend 300MHz Pentium or equivalent for adequate speed
- Note: development was done in Unix/Linux environments.

Coming in January 2000: *Runtime IDL version and 24-bit truecolor.*

Download the current version of **Corner Cube** from the **INC** website <http://pet.med.va.gov:8080/hbp.html> by following the link to *Resources*.



## Test Drive

A "test drive" version, **Corner Cube on the Web**, is available which allows a visitor to interact with Corner Cube by using a set of predefined datasets or by entering a minimal description of a set of foci. A clickable image is then computed and returned along with nearby anatomical structure names.

Test drive Corner Cube by visiting the **INC** website <http://pet.med.va.gov:8080/hbp.html> and follow the link to *What's New*.

## Acknowledgment

This work was supported in part by NIH grants MH57180, NS33718 and DA09246.